Available online at www.sciencedirect.com
SCIENCE DIRECT
Industrial Crops and Products 24 (2006) 60–65
INDUSTRIAL CROPS AND PRODUCTS
AN INTERNATIONAL JOURNAL
www.elsevier.com/locate/indcrop

Guayule seed germination under different conditioning treatments

Marçal H.A. Jorge [a,b], Maren E. Veatch-Blohm [a], Dennis T. Ray [a,*], Michael A. Foster [c]

[a] *Division of Horticultural and Crop Sciences, Department of Plant Sciences, The University of Arizona, Tucson, AZ 85721, USA*
[b] *EMBRAPA Pantanal, Corumba, Brazil*
[c] *The Texas A&M University System, Texas Agricultural Experiment Station, P.O. Box 1549, Pecos, TX 79772, USA*

Received 19 July 2005; received in revised form 9 February 2006; accepted 9 February 2006

Abstract

Guayule (*Parthenium argentatum* Gray), a latex producing shrub from northern Mexico and southwestern Texas, has been considered a viable alternative commercial crop for arid lands throughout the world. Stand establishment by direct seeding has been ineffectual because of problems with seed germination. Seed dormancy has been ascribed as one of the main reasons for low germination. Special seed treatments, such as physical and chemical conditioning, have been devised to overcome embryo and seed coat dormancy, thereby improving germination and emergence. However, the treatments described in the literature have not been as effective as expected, and many of them are costly and time consuming. The objective of this study was to determine the effects of nine preconditioning treatments on the percentage and rate of germination and emergence, and seedling fresh weight. Three-year-old seed of lines AZ-101, AZ-3, and N9-3 were analyzed with X-ray to determine the seed lot quality. The results showed differences in quality (defined as seeds containing embryos and endosperm) among the three lines; however, no differences were found for percentage and rate of germination and emergence, and seedling fresh weight among the nine treatments. These results suggest that in older seed lots seed quality is of greater importance in determining germination and emergence than conditioning treatments.

Keywords: Guayule; New crops; Seed quality; Seed conditioning; Direct seeding; *Parthenium argentatum*

1. Introduction

Guayule (*Parthenium argentatum* Gray) is native to the semi-arid regions of the Chihuahuan Desert in northern Mexico and southwestern Texas (Lloyd, 1911; McCallum, 1926). Guayule is a perennial shrub (Rollins, 1950) with adaptations for growth in warm semi-arid regions (Downes, 1986; Nix, 1986), and is currently being cultivated successfully in different parts of the world as a potential non-allergenic rubber crop (Nix, 1986; Carey et al., 1995).

Stand establishment is of primary importance for optimizing field production of any crop. For guayule, growers and researchers have been unable to obtain satisfactory stands utilizing direct seeding (Foster and Coffelt, 2005). Poor germination is thought to be the result of seed dormancy and has been suggested as the cause of poor stand establishment (Benedict and Robinson, 1946; Naqvi, 1985). Two types of seed dormancy have been reported for guayule: (a) embryo dormancy, and (b) seed

* Corresponding author. Tel.: +1 520 6217612; fax: +1 520 6217186.
E-mail address: dtray@u.arizona.edu (D.T. Ray).

0926-6690/$ – see front matter © 2006 Elsevier B.V. All rights reserved.
doi:10.1016/j.indcrop.2006.02.002

coat dormancy (Benedict and Robinson, 1946). Naqvi (1985) suggested a special seed treatment to overcome both types of dormancy to allow guayule seed to germinate, and thus obtain the best field emergence possible.

Embryo dormancy generally lasts only 2 months after the seed has been harvested, and is thought to be broken naturally by light exposure (Hammond, 1959). However, embryo dormancy can be broken earlier by treatment with gibberellin (GA_3) (Naqvi and Hanson, 1980). Seed coat dormancy may last from 1 to 4 years when the seeds are stored unthreshed and longer when they are stored at a moisture content of around 4%, but can be broken by mechanical and chemical processes (McGinnies, 1975; McGinnies and Mills, 1980; Fangmeier et al., 1984). Threshing removes many of the physical barriers involved in seed coat dormancy allowing a substantial proportion of the good quality seeds to germinate readily under favorable conditions, whereas the dormancy of the remainder of the threshed seed disappears within 6 months (Hammond and Polhamus, 1965; McGinnies, 1975; McGinnies and Mills, 1980). Seed coat dormancy can also be broken chemically by oxidizing agents (Benedict and Robinson, 1946) such as sodium hypochlorite (NaOCl) (McGinnies, 1975). In general, embryo dormancy is important for freshly harvested seeds, whereas seed coat dormancy is of greater importance for seed lots older than 2 months (Hammond and Polhamus, 1965; McGinnies, 1975; McGinnies and Mills, 1980; Fangmeier et al., 1984).

Treatments described in the literature to enhance guayule seed germination use a wide variety of solutions and concentrations (Hammond, 1959; McGinnies, 1975; Naqvi and Hanson, 1980; Rominger, 1982; Chandra and Bucks, 1986a,b; Hayman and Yokoyama, 1990). Soaking seeds in water for 8 h prior to washing with NaOCl was shown to be more beneficial to germination than using either process alone or in reverse because soaking is thought to make the seed more responsive to the NaOCl (McGinnies, 1975). A different approach by Chandra and Bucks (1986b) involved a solution containing polyethylene glycol (PEG), KNO_3, GA_3, and Thiram, with their investigations centered primarily on the effect of PEG concentrations ranging from 5 to 30%. It was shown that osmotically stressed guayule seeds exhibited high viability and vigor. In addition, the intrinsic viability and vigor characteristics of the seeds were well preserved under this type of osmotic stress. However, while some seeds in the seed lot had the potential to overcome osmotic stress, others could not, and it could be related to the intrinsic vigor of the embryo. Chandra and Bucks (1986a) also tested the effects of the fungicides Thiram, Terrachlor, Metalaxyl, Benlate, and Captan on seed germination, and concluded that in order to control fungal infestation a fungicide in optimum amounts, should be incorporated into the seed conditioning medium.

Preliminary studies (Jorge and Ray, unpublished results), showed that seed quality varied within and among seed lots when tested in germination and emergence tests. It was during these tests that we began to question the effectiveness of seed conditioning treatments. Our preliminary data showed that germination and emergence did not appear to be influenced by seed conditioning, but depended on seed age and quality. However, we felt that even in older seed lots where only seed coat dormancy should be a factor, conditioning might also improve germination and emergence by providing uniformity of growth, thus reducing the seeds' exposure to unfavorable environmental conditions.

Guayule seed conditioning treatments are being used by growers and researchers in an attempt to improve germination and get desirable stands regardless of the age of the seed; however, many of these conditioning treatments are time consuming and expensive. The objective of this study was to determine the effects of nine different preconditioning treatments on guayule percentage and rate of germination and emergence, and seedling fresh weight.

2. Materials and methods

The study was conducted at the University of Arizona, Campus Agricultural Center, Tucson, Arizona in 2005 using seeds collected at the USDA-ARS Water Conservation Laboratory in Phoenix, Arizona in 2002. Although the guayule seed is actually an achene, it will be referred to as a seed throughout the paper. In these studies, three guayule germplasm lines were chosen for examination, AZ-101, AZ-3, and N9-3.

Raw seeds were pre-cleaned using a clipper cleaner; whereas additional threshing was performed using medium-grain sandpaper and hand screens shortly before conditioning treatments were applied. Further separation of the seeds by color was performed using an illuminated magnifying scope. Yellow seeds were excluded from the study because X-ray analysis revealed an absence of internal structures essential for germination, which in previous work was correlated with no germination (Jorge and Ray, 2005). In contrast, the gray, opaque black, and dark black seeds used for this study have a higher number of filled seeds based on X-ray analysis, which is correlated with higher germination (Jorge and Ray, 2005). To confirm correct color separation, a chroma meter (Model CR-200, Minolta Camera Com-